AD A116987

MECHANICAL-PROPERTY DATA Ti-10V-2Fe-3Al ALLOY

ISOTHERMALLY FORGED

Issued by

Air Force Wright Aeronautical Laboratory
Materials Laboratory
Wright-Patterson Air Force Base, Ohio

June 1982

Prepared by

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F33615-80-C-5168

This data sheet was prepared by Battelle's Columbus Laboratories under Contract No. F33615-80-C-5168, under the direction of the Air Force Wright Aeronautical Laboratories, Materials Laboratory, by Mr. Neal Ontko, MLSA, Technical Monitor.

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Ti-10V-2Fe-3Al Isothermally Forged

Material Description

Ti-10V-2Fe-3Al is a recently developed, metallurgically near-beta alloy. The alloy is capable of attaining a variety of strength levels, depending on the selection of heat treatment. A major advantage over other alloys is the excellent forgeability. It forms readily at temperatures below those required for Ti-6Al-4V.

The Ti-10V-2Fe-3Al material used in this evaluation was received as 6 discs 7 inches (178 mm) in diameter x 1/2-inch (12.7 mm) thick. The material was produced by RMI and isothermally forged by TRW.

The chemical composition of this lot is as follows:

Chemical Composition	Percent Weight
Vanadium	9.5
Aluminum	3.2
Iron	1.9
Titanium	Balance

Processing and Heat Treating

A 30-inch (762 mm) diameter cast ingot was first heated to 2200 F (1478 K) and forged to a 24-inch (610 mm) round cornered square (RCS). The billet was then heated to 1400 F (1033 K) and forged to a 20-inch (508 mm) RCS, reheated to 1700 F (1200 K) and forged to a 15-inch (381 mm) RCS, reheated to 1700 F (1200 K) and once more forged to an 11-inch (279 mm) RCS bar. Conditioning of the piece was conducted as needed during the processing. A section of the material was then cut, heated to 1375 F (1019 K) and forged into an 8-inch (203 mm) RCS, reheated to 1700 F (1200 K) and forged to a 5-inch (127 mm) RCS, reheated to 1500 F (1089 K) and forged to a 4-inch (102 mm) octagon. A final pass at RMI was performed in a rotary forging machine at 1500 F (1089 K) transforming the octagon into a 3-1/4-inch (8.26 mm) diameter round bar.

At TRW the round bar was conventionally upset 25% at 1525 F (1103 K), conventionally drawn 40% at 1525 F (1103 K), isothermally drawn 50% at 1525 F (1103 K), and isothermally forged 50% to the final shape. The material was subsequently heat treated as follows: 1435 F (1043 K)/ 2 hours/air cool, 1425 F (1047 K)/2 hours/water quench, and 945 F (780 K)/ 8 hours/air cool (STA).

Ti-10V-2Fe-3Al[a]

Condition: STA
Thickness: 1/2-inch (12.7 mm)

Properties	Temperature, F (K)			
	RT	(RT)	600	(587)
Tension				
TUS, L, ksi (MPa)	179.2	(1235.6)	153.2	(1056.3)
TUS, T, ksi (MPa)	178.8	(1232.8)	154.9	(1068.0)
TYS, L, ksi (MPa)	173.9	(1199.0)	136.6	(941.9)
TYS, T, ksi (MPa)	173.7	(1197.7)	141.2	(973.6)
e, L, percent in 2 in. (50.8 mm)	2.3		8.3	
e, T, percent in 2 in. (50.8 mm)	2.0		6.5[b]	
E, L, 10^3 ksi (GPa)[d]	15.46	(106.6)	13.98	(96.4)
E, T, 10^3 ksi (GPa)[d]	15.12	(104.2)	13.98	(96.4)
Compression				
CUS, L, ksi (MPa)[b,c]	213.7	(1473.5)		
CUS, T, ksi (MPa)	211.4	(1457.6)		
CUS, T, ksi (MPa)	191.8	(1322.5)		
E_c, L, 10^3 ksi (GPa)[b,d]	16.60	(114.4)		
E_c, T, 10^3 ksi (GPa)[d]	16.09	(110.9)		
Shear				
SUS, L, ksi (MPa)	98.6	(679.8)		
SUS, T, ksi (MPa)	101.5	(699.8)		
Bearing				
e/D = 1.5				
BUS, L, ksi (MPa)	247.1	(1703.8)		
BUS, T, ksi (MPa)	264.8	(1825.8)		
BYS, L, ksi (MPa)	243.0	(1675.5)		
BYS, T, ksi (MPa)	258.9	(1785.1)		
e/D = 2.0				
BUS, L, ksi (MPa)	321.2	(2214.7)		
BUS, T, ksi (MPa)	309.5	(2134.0)		
BYS, L, ksi (MPa)	289.9	(1998.9)		
BYS, T, ksi (MPa)	280.8	(1936.1)		
Axial Fatigue (Transverse)				
Unnotched, R = 0.1				
10^3 cycles, ksi (MPa)	170	(1172)		
10^5 cycles, ksi (MPa)	120	(827)		
10^7 cycles, ksi (MPa)	110	(758)		
Notched, K_t = 3.0, R = 0.1				
10^3 cycles, ksi (MPa)	105	(724)		
10^5 cycles, ksi (MPa)	45	(310)		
10^7 cycles, ksi (MPa)	40	(276)		

(a) Values are average of triplicate tests conducted at Wright Aeronautical Laboratories, Materials Laboratory, unless otherwise indicated. Fatigue values are from curves generated using the results of a greater number of tests.

(b) Data from only two tests.

(c) Ultimate strength value only due to test problems.

(d) The values presented are indicative of modulus values typical for titanium alloy materials; however, the instrumentation did not meet ASTM E83 class A extensometer requirements.

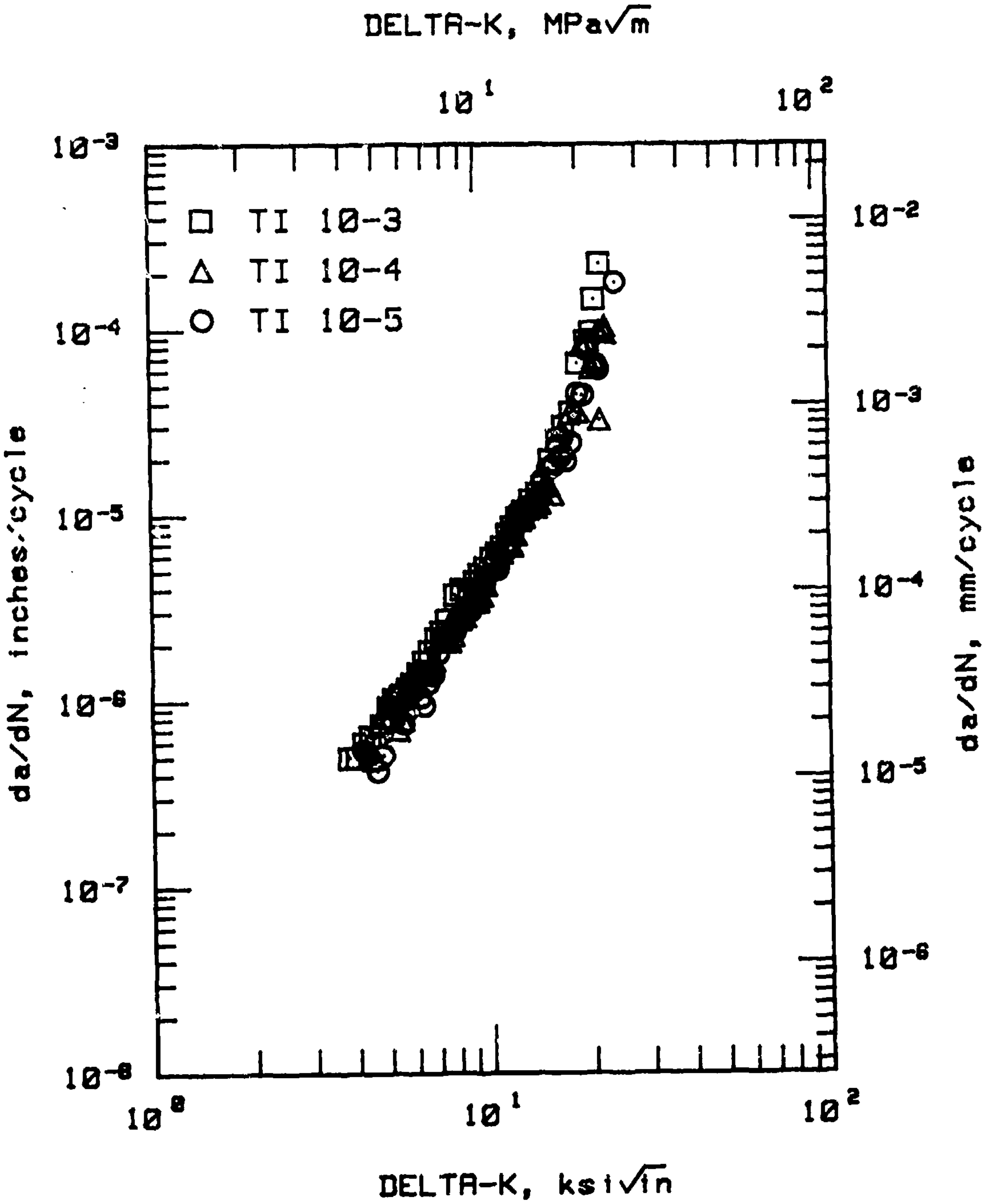

FIGURE 1. da/dN VERSUS DELTA K FOR Ti-10V-2Fe-3Al ALLOY.

Lab Air
Room Temperature
R = 0.1
Frequency = 30 Hz
Specimen Orientation = L-T

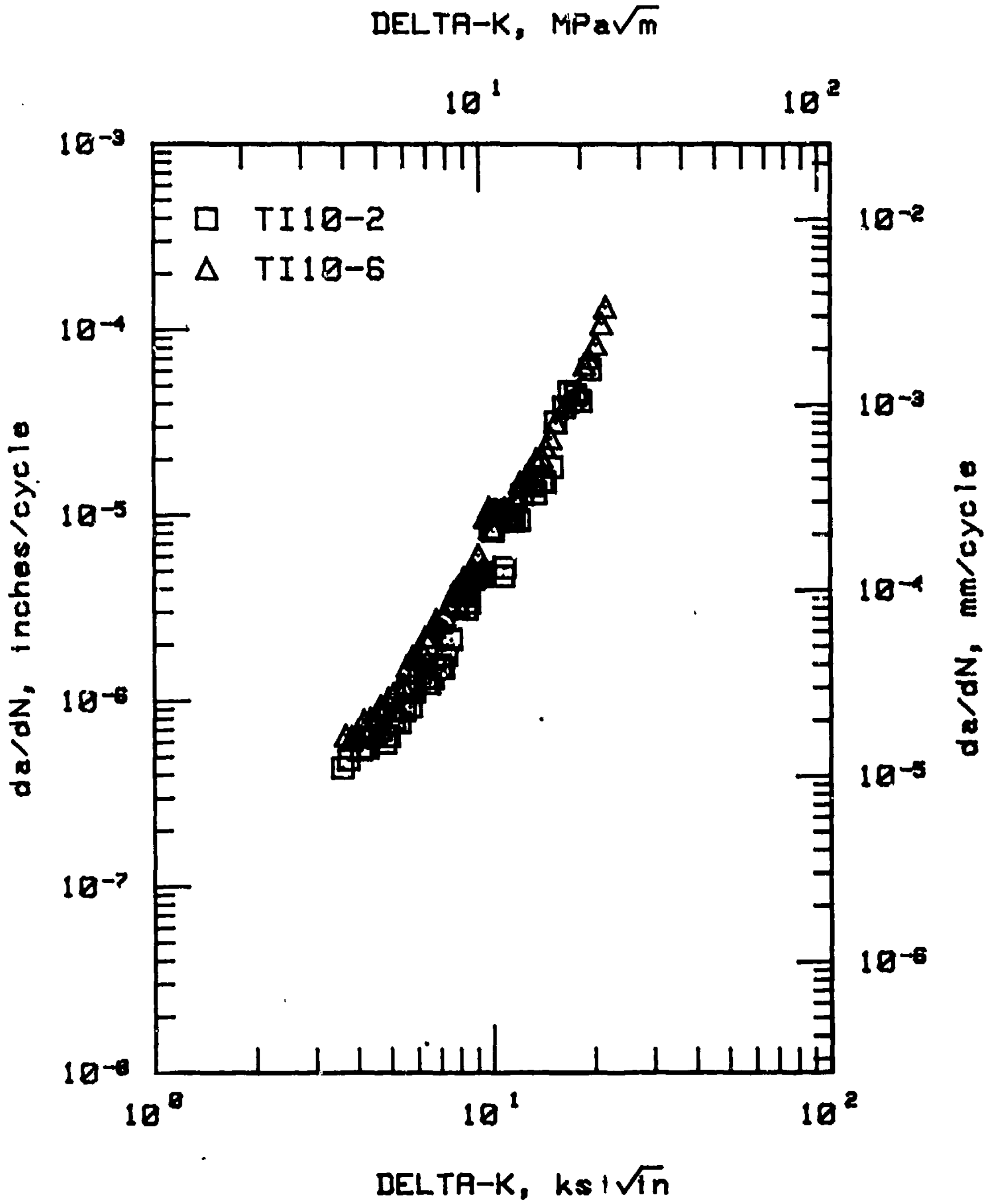

FIGURE 2. da/dN VERSUS DELTA K FOR Ti-10V-2Fe-3Al ALLOY.

Lab Air (Heated)
600 F (589 K)
R = 0.1
Frequency = 30 Hz
Specimen Orientation = L-T

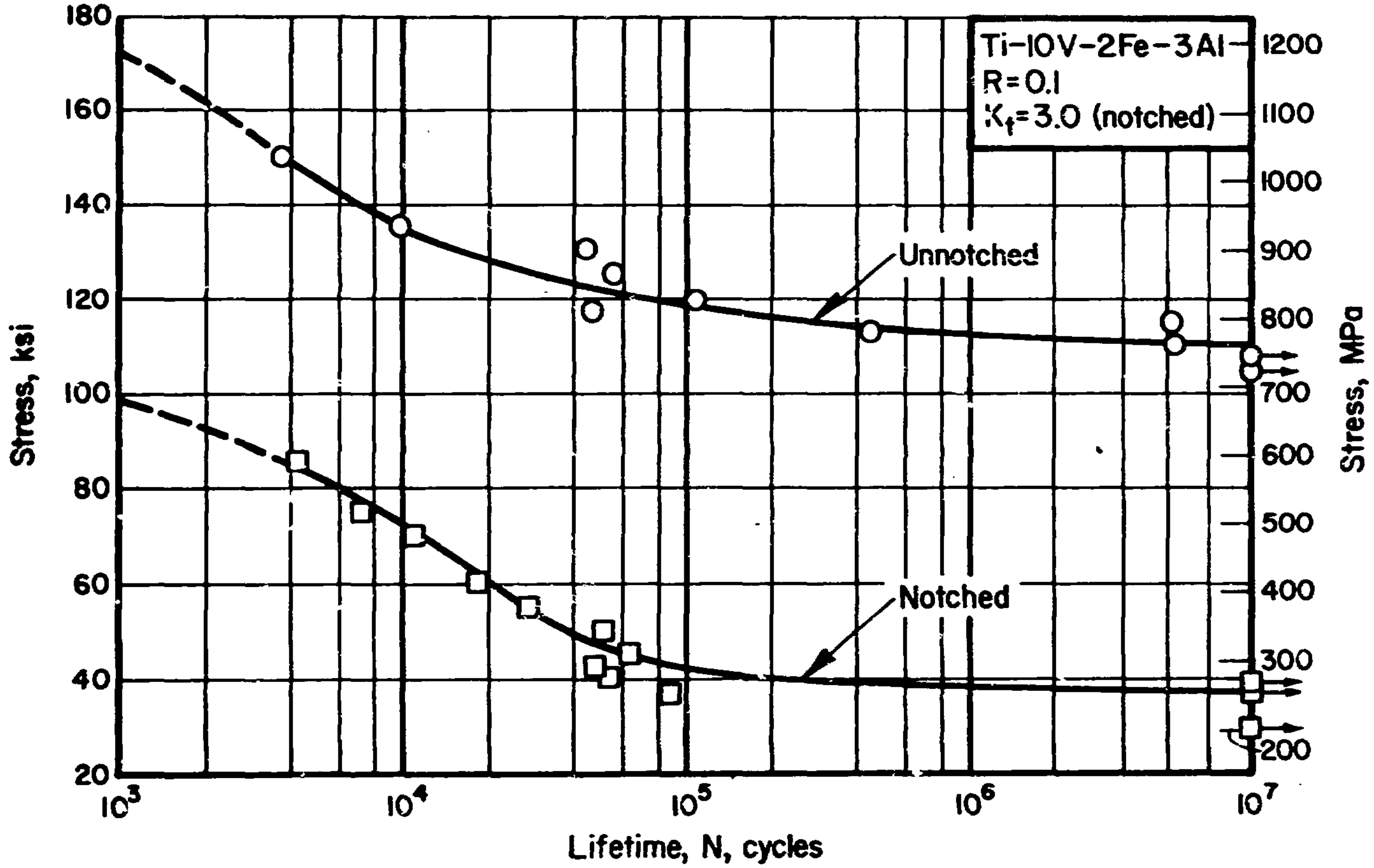

FIGURE 3. AXIAL LOAD FATIGUE BEHAVIOR OF UNNOTCHED AND NOTCHED (K_t = 3.0) Ti-10V-2Fe-3Al ALLOY AT ROOM TEMPERATURE